DIVERSITY AND DISTRIBUTION OF VERTIGINIDAE (MOLLUSCA: GASTROPODA) IN THE LANGKAWI ISLANDS, KEDAH

by

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mya	million years ago
uPl	upper palatal
lPl	lower palatal
b	basal
C	columellar lamellae
P	parietal lamellae
A	angular lamellae

KEPELBAGAIAN DAN TABURAN VERTIGINIDAE (MOLUSKA: GASTROPODA) DI PULAU LANGKAWI, KEDAH

Abstrak

Suatu kajian terhadap kepelbagaian dan taburan siput bersaiz mikro daripada famili Vertiginidae telah dijalankan di 16 lokasi yang meliputi kawasan batu kapur di Pulau Langkawi yang terletak di bahagian utara Selat Melaka. Sejumlah 10 spesies dari tiga genus telah dikenalpasti, tujuh spesies dari genus *Gyliotrachela*, iaitu *G. depressispira*, *G. hungerfordiana*, *G. luctans*, *G. salpinx*, *G. transitans helioscopia*, *Gyliotrachela* sp.1 dan *Gyliotrachela* sp.2; dua spesies dari genus *Paraboysidia*, iaitu *P. frequens* dan *P. serpa*; dan satu spesies yang tidak diketahui dari genus *Nesopupa*. Tiga spesies yang tidak diketahui tersebut merupakan rekod baru di Malaysia. Proses identifikasi dan pengesahan siput tersebut dilakukan dengan bantuan koleksi rujukan di British Natural History Museum, London. *Gyliotrachela hungerfordiana* merupakan spesies yang paling biasa ditemui di Pulau Langkawi, di mana ia boleh dijumpai di sepuluh lokasi kajian.

Kajian ini juga mendapati variasi morfologi di dalam sesuatu spesies "vertiginid" mungkin disebabkan oleh pemisahan geologi formasi batu kapur di Pulau Langkawi. Ujian korelasi Pearson menunjukkan terdapat pertalian korelasi sederhana antara kelimpahan vertiginid dan intensiti cahaya (r_W = 0.614 dan r_D = 0.537 pada paras keertian 95%) semasa musim hujan dan kering, manakala diversiti spesies pula menunjukkan pertalian korelasi sederhana dengan kelembapan udara relatif (r = 0.654 pada paras keertian 99%) dan suhu persekitaran (r = 0.515 pada paras keertian 95%) semasa musim hujan. Analisis NMDS tidak menunjukkan perhubungan yang ketara di antara parameter persekitaran yang lain (orientasi dan

keadaan dinding batu kapur di mana siput dijumpai, dan liputan kanopi tumbuhan) dengan kelimpahan “vertiginid” di kawasan kajian.

DIVERSITY AND DISTRIBUTION OF VERTIGINIDAE (MOLLUSCA: GASTROPODA) IN THE LANGKAWI ISLANDS, KEDAH

Abstract

A study was conducted on the diversity and distribution of microsnails from the family Vertiginidae at 16 locations that spreads across the limestone outcrops of the Langkawi Islands in the northern Straits of Malacca. A total of 10 species of vertiginids from three genera were identified with seven species from the genus *Gyliotrachela*, namely, *G. depressispira*, *G. hungerfordiana*, *G. luctans*, *G. salpinx*, *G. transitans helioscopia*, *Gyliotrachela* sp. 1 and *Gyliotrachela* sp. 2; two species from genus *Paraboysidia*, namely, *P. frequens* and *P. serpa*; and one unknown species from genus *Nesopupa*. Consequently the three unknown species are new records for Malaysia. Identification and confirmation of the snails was done using the reference collection at the British Natural History Museum in London. *Gyliotrachela hungerfordiana* was found to be the most common Vertiginidae species in Langkawi having been found in ten sampling locations.

This study also revealed that the morphological variations within vertiginids species at Langkawi Islands might be caused by the geological separation of the limestone formation. Pearson correlation coefficient showed that the abundance of vertiginids showed moderate correlation (r_W = 0.614 and r_D = 0.537 at 95% significance level) with the light intensity during wet and dry sampling season, while the species diversity of vertiginids showed moderate correlation with relative air humidity (r = 0.654 at 99% significance level) and ambient temperature (r = 0.515 at 95% significance level) during the wet season. Non-metric multidimensional scaling (NMDS) analysis showed no apparent relationship between other environmental parameters (orientation and condition of limestone wall on which the snails are

found. and plant canopy coverage) with the abundance of vertiginids in the sampling location.

CHAPTER 1:

INTRODUCTION

1.1 Background

The Vertiginidae, is a large family of microsnails, generally less than 5 mm in dimension. The shells are mostly pupa-shaped or cylindriform to conical, but most of the Southeast Asian species has a shape like a trumpet, which correspond to the expanded apertural lip. Many of the species possess apertural barriers ("denticles" or "teeth") (**Figure 1.1**). The taxonomy of Vertiginidae was primarily developed based on shell characters and taxonomists relied heavily on the patterns of these barriers to determine the taxonomic relationship.

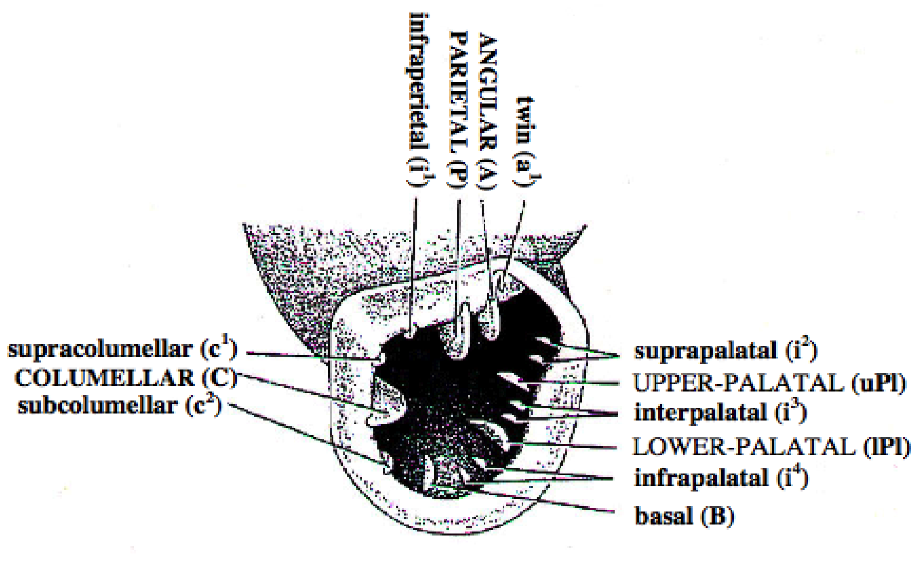

Figure 1.1 Terminology of the apertural barriers (Panha & Burch, 2005).

Based on Pilsbry (1916-1918), which had examined the nomenclature for these barriers extensively, the plicae (singular, plica), also called folds, are denticles located on the outer lip, whereas lamellae (singular, lamella) are denticles located on the columellar lip and parietal wall. The primary denticles are columellar lamella (C), parietal lamella (P), angular lamella (A), upper palatal plica (upl), and lower palatal plica (lPl). Additional barriers to these, depending on the species, are twin lamella (a^1), basal plicae (B), infraparietal lamella (i^1), suprapalatal plica (i^2), interpalatal plica (i^3), infrapalatal plica (i^4), supracolumellar lamella (c^1), and subcolumellar lamella (c^2) (**Figure 1.1**).

Table 1.1 shows the key shell characters that are used to differentiate the five major vertiginids genera, which can be found in Southeast Asia following the description by Pilsbry (1916-1918) and Panha and Burch (2000). Based on the shell morphological characteristics, these groups may be classified as follows: *Krobylos* always lack apertural barriers, whereas some of the *Aulacospira* do possess them. Both genera have depressed helicoid shells, and do not develop tuba. *Hypselostoma, Gyliotrachela* and *Anauchen* have turrited shells, either elongated or depressed, and the terminal whorls often form the tuba. *Anauchen* lacks the angular lamella; both *Hypselostoma* and *Gyliotrachela* have both angular and parietal lamellae. Both lamellae are fused into one irregular lamella in *Hypselostoma* but they are independent and parallel in *Gyliotrachela*. *Paraboysidia* has similar characteristics as *Gyliotrachela* except that the last whorl is not free.

Table 1.1 Shell characters used to differentiate six major vertiginids genera in the Southeast Asia based on descriptions from Pilsbry (1916-1918), Panha and Burch (2000) (from Tongkerd, 2003) and Benthem-Jutting (1950).

Shell characters	**Taxa**					
	Hypselostoma	***Gyliotrachela***	***Anauchen***	***Aulacospira***	***Krobylos***	***Paraboysidia***
Conic spire either elevated or depressed Last whorl free, either straight or ascending	✓	✓				
Elongate, pyramidal spire Last whorl not free			✓			✓
Helicoid Last whorl free, descending				✓		
Helicoid last whorl adnate Peristome present only at columellar margin					✓	
Aperture without barriers				✓	✓	
Aperture with barriers	✓	✓	✓	✓		✓
Angular and parietal lamellae fused into one irregular lamellae 	✓					
Angular and parietal lamellae independent and parallel 		✓				✓
Angular lamellae absent			✓	✓		

1.2 Classification of Vertiginidae

The classification of the family Vertiginidae of Langkawi Islands is shown below (Abbott and Boss, 1989):

Phylum Mollusca

Class Gastropoda

Subclass Pulmonata

Order Stylommatophora

Suborder Orthurethra

Superfamily Pupilloidea

Family Vertiginidae (Pupillidae)

Genus *Gyliotrachela* Tomlin, 1930

Genus *Nesopupa* Pilsbry, 1900

Genus *Paraboysidia* Pilsbry, 1917

The family Vertiginidae is the primary family in the superfamily Pupilloidea (Infraorder Orthurethra), which is one of the two stylommatophoran superfamilies to have achieved a world wide distribution with endemic representatives on all continents, except Antarctica (Pilsbry, 1935; Solem, 1979).

1.3 Distribution of Vertiginidae

Vertiginidae is a large family of micro land snails that are found in both terrestrial and arboreal habitats (Solem, 1979). They occur in two very distinct habitats: the forest litter and on the rock surface of limestone hills. The latter is more common to the Southeast Asian species (Benthem-Jutting, 1950). Usually these obligate limestone rock-dwellers have highly modified adult shell morphology whereby the last part of the body whorl is an uncoiled trumpet-shaped extension or tuba (Pilsbry, 1916-1918) (**Plate 1.1**).

Plate 1.1 Common example of obligate limestone rock-dwellers, *Gyliotrachela hungerfordiana.*

In Peninsular Malaysia, most of the limestone formations have never been connected geographically and ecologically (Schilthuizen, 2000). This resulted in the vertiginids being restricted to specific hills or hill clusters and displaying such a high degree of endemism (Benthem-Jutting, 1950). Altogether, there are about 24 species from four genera of described vertiginids in Peninsular Malaysia (Maassen, 2001). Langkawi is not included in the list and according to Davison (1991) the malacofauna in the island was the least understood due to lack of study. **Figure 1.2** shows the general distribution of vertiginids in Peninsular Malaysia compiled from the work of Maassen (2001). Most of the vertiginids were found in the area where there are abundant limestone substrate.

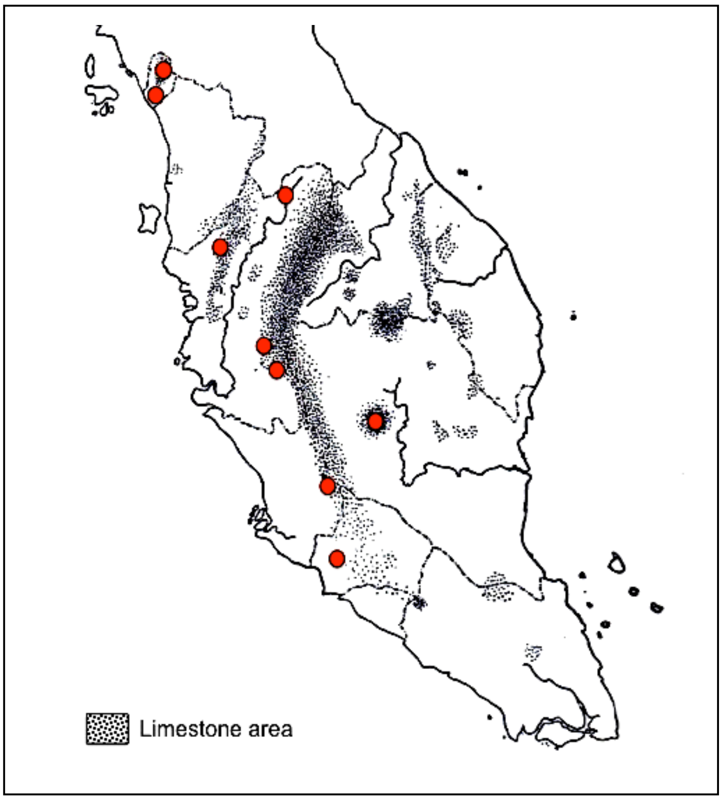

Figure 1.2 General distributions of vertiginids in Peninsular Malaysia as shown by the red circle in the map. These are mostly located on the areas where the limestone substrate is abundant in the peninsular (modified from Maassen, 2001).

1.4 Importance of study

The importance of this study is as follows:

a. snails are ideal models to understand our changing environment, and the roles of history and selection of the origins of diversity of our fauna. This is because snails have low ability to disperse in a large area, thus any change in the environment will certainly affect their diversity and distribution.

b. family Vertiginidae was chosen because of their small size, abundance and the populations are often left undisturbed, which is suitable candidate for the diversity and distribution study.

c. this study will also addresses the lack of baseline information of terrestrial molluscan fauna study on Langkawi Islands, which has been reported by Davison (1991).

1.5 Scope and objectives

This study was concerned with the Vertiginidae of Langkawi in the aspects of the classification, distribution and diversity, and as well as the ecology. These aspects were largely ignored until relatively recently, when the awareness to conserve the endemic group of microsnails had arisen. On top of that, Langkawi has a preferably extensive rainforest margin with island karst landscape, which is an essential requirement for the microsnails, alongside with the unique geological history that could be traced back to the Paleozoic era (approximately 570 mya). This will provide opportunities to discover the relationship of an organism with its environment more comprehensively.

Therefore, the objectives of this study are:

a. to classify the Vertiginidae of Langkawi Islands to the lowest taxonomic level possible by using shell morphological characteristics.

b. to determine the diversity and distribution of vertiginids on the islands, and,

c. to investigate the relationship between environment and the diversity and abundance of vertiginids on the islands.

CHAPTER TWO:

MATERIALS AND METHOD

2.1 Study area

Langkawi Archipelago is a part of Malaysia's Kedah state and located about 30km west of Perlis and Satun (southern Thai Province) coastlines. To its north, Langkawi is separated by a narrow strait less than 20 km away from Ko Tarutao, which also belongs to Thailand. The land area of Langkawi archipelago covers approximately 478 km^2 and is situated between latitude 6°10' N to 6°30' N and longitude 99°35' E to 100°E (Leman *et al.*, 2007) **(Figure 2.1)**. Sixteen karsts were sampled in Langkawi for this study, as shown in **Figure 2.2** and **Table 2.1**.

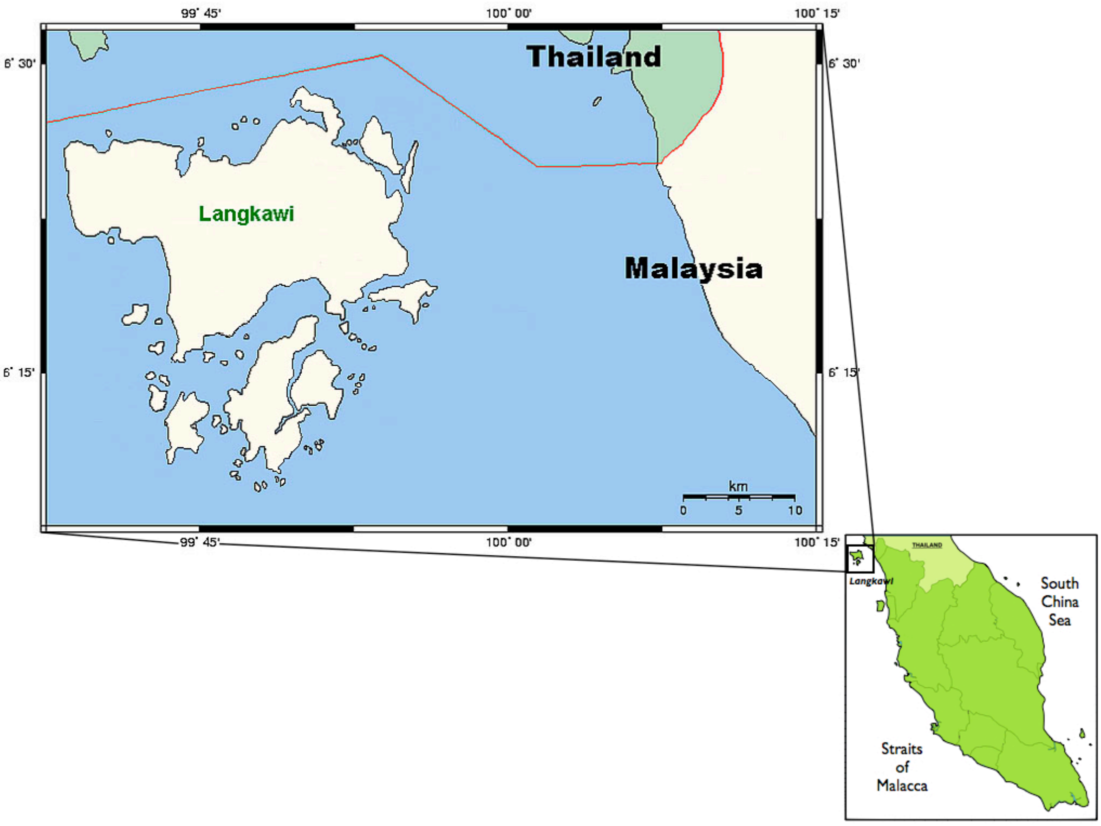

Figure 2.1 Map of the study site, Langkawi and its location relative to Peninsular Malaysia.

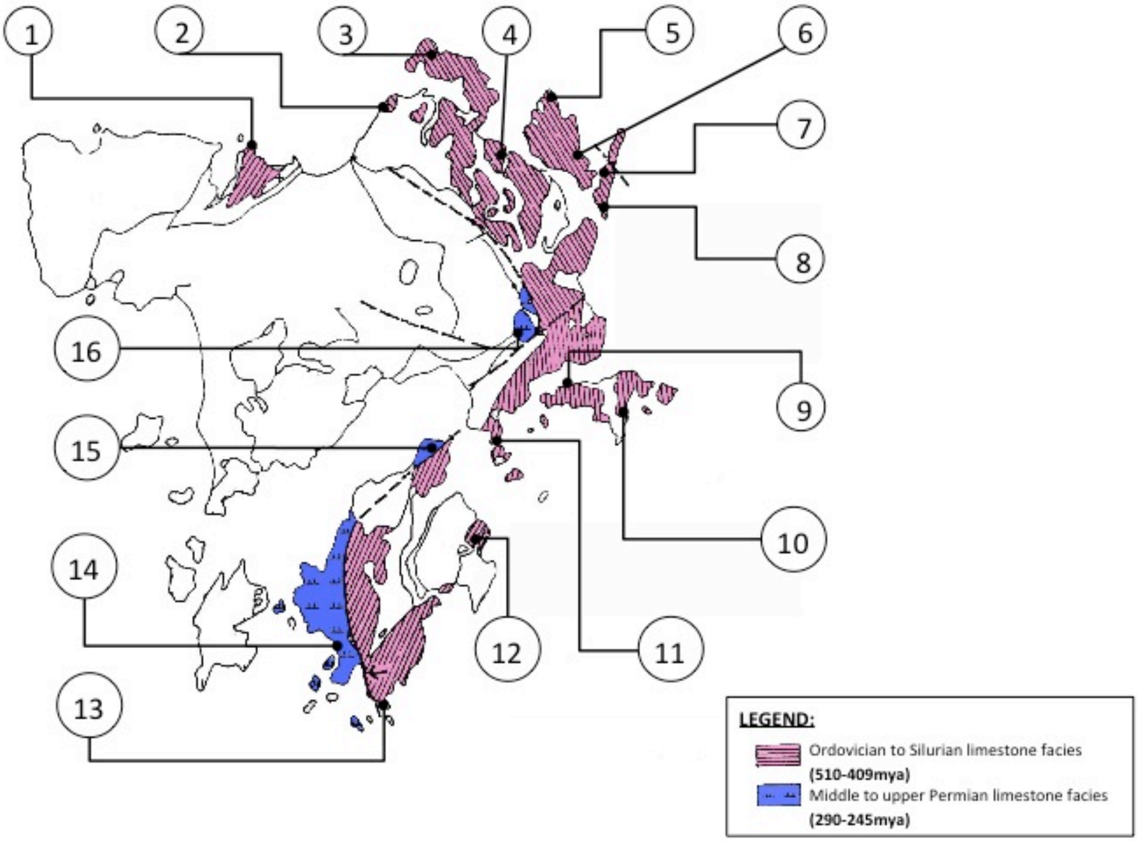

Figure 2.2 Sampled karsts in Langkawi. See **Table 2.1** for corresponding karsts names.

Table 2.1 Coordinates of each sampled karsts.

No.	Karst name	Coordinates
1	Teluk Ewa, Pulau Langkawi	6°25'N 99°45'E
2	Tanjung Rhu, Pulau Langkawi	6°27'N 99°50'E
3	Gua Cherita, Pulau Langkawi	6°28'N 99°51'E
4	Gua Kelawar, Pulau Langkawi	6°24'N 99°52'E
5	Teluk Mempelam, Pulau Langgun	6°27'N 99°53'E
6	Talam Dua Muka, Pulau Langgun	6°25'N 99°54'E
7	Tanjung Dendang 1, Pulau Tanjung Dendang	6°25'N 99°55'E
8	Tanjung Dendang 2, Pulau Tanjung Dendang	6°24'N 99°55'E
9	North of Timun, Pulau Timun	6°19'N 99°55'E
10	South of Timun, Pulau Timun	6°19'N 99°54'E
11	Gua Landak, Pulau Langkawi	6°18'N 99°52'E
12	Pulau Tuba	6°15'N 99°51'E
13	South Dayang Bunting, Pulau Dayang Bunting	6°12'N 99°50'E
14	Tasik Dayang Bunting, Pulau Dayang Bunting	6°12'N 99°47'E
15	North Dayang Bunting, Pulau Dayang Bunting	6°16'N 99°50'E
16	Kisap, Pulau Langkawi	6°21'N 99°52'E

2.1.1 Topography and geology

The topography and geology of Langkawi islands today is a result of a very long depositional history under the various paleoenvironmental conditions (Ali *et al*., 2008). In general, there are four sedimentary rock formations and one granite formation in Langkawi. These sedimentary rock formations are the Cambrian Machinchang, Ordovician to Middle Devonian (Silurian) Setul, Late Devonian to Early Permian Singa and Middle to Late Permian Chuping Formations (Ali *et al*., 2008) **(Figure 2.3)**. The sequence of these sedimentary rock formations is generally younger towards the east.

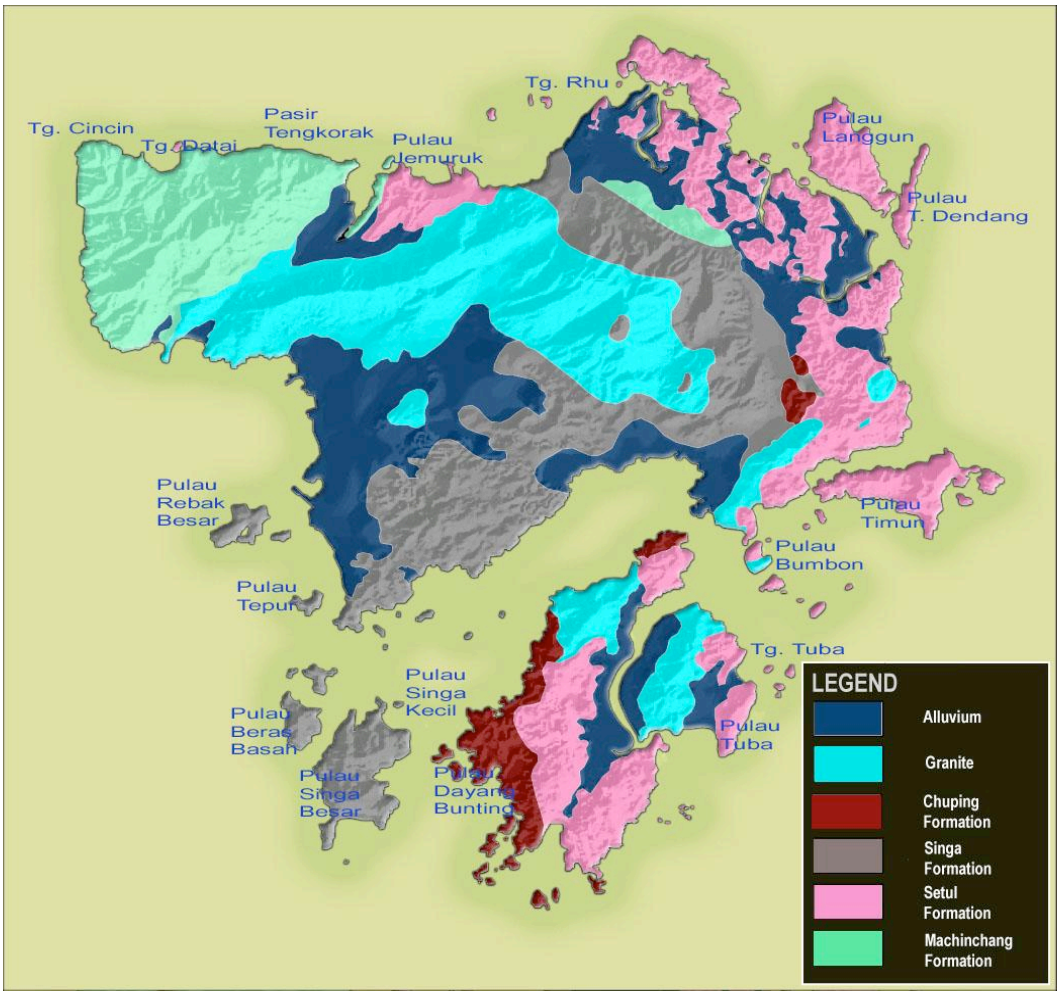

Figure 2.3 Geological map of Langkawi Islands showing the distribution of various rock formations in the islands (from Leman *et al*., 2007).

However, only two geological formations are of the most interest in this study: Setul Formation and Chuping Formation, which consist of limestone **(Figure 2.2** and **2.3)**. The details of each formation are given as below:

Setul Formation (Ordovician to Silurian)

Older Ordovician to Silurian limestones have a few thin bands of shale, and are dark grey-black or black in colour. They also have a higher argillaceous (clay mineral) content than the younger limestones. These support sufficient residual soil to support fairly abundant vegetation. These older limestones give rise to more or less continuous ranges of hills without marked vertical cliffs (Price, 2001).

Chuping Formation (Middle to upper Permian)

Younger Permian limestones produce more isolated hills with notably higher, vertical or even overhanging cliffs. The limestones usually outcrop as aligned ridges or towers, which dominate the plains. The hills are often very small; mostly a few hundred meters across. These characteristic hills are often isolated and have sheer, vertical cliffs, with distinctive flora of semi-drought vegetation compared to the normal rain forest. The residual soils on the outcrops are meager and support only thin scrubby vegetation (Price, 2001).

2.1.2 Climate

Langkawi experiences the same weather conditions as in the mainland. The temperature ranges from 22.5°C to 34.5°C and the monthly rainfall varies from 69mm to 870mm. Langkawi also experiences distinct dry and wet season throughout the year. The dry season takes place for 2 to 3 months between December and March, and the wet season may occur in the month of September to November **(Table 2.2)**. This type of climate influences the type of vegetation found here, which is similar to that of Burma and Thailand (Leman *et al.*, 2007).

Table 2.2 Weather data from Malaysian Meteorological Department for the year 2008.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean monthly temperature (°C)	28.3	28.8	28.7	28.7	28.2	28.0	27.7	27.8	27.6	27.2	27.4	27.6
Mean monthly rainfall (mm)	47.5	21.4	95.5	220.0	248.7	282.3	314.5	302.9	399.7	346.7	255.8	89.3

2.1.3 Vegetation

The weathering of granite and shale/mudstone formed thicker soils that retain water and nutrients to support larger trees during the long dry spell, which resulted in more permanent forests in these areas. They are also responsible in supplying clayey soils in the low flatland, riverbank, mangrove-plain and tidal flat. However, Machinchang sandstone, Setul limestone and Chuping marble are less vegetated due to its more weather-resistant nature compared to those of granite and shale/mudstone bedrocks.

2.2 Sampling protocol

The sampling protocol was modified from Clements *et al.* (2008). All karsts were sampled at their cliff bases to control species heterogeneity among karsts microhabitats. Collection of specimens was done twice: once during the wet season (November 2008) and once during the dry season (February 2009). On each karst, five replicate quadrats (1 x 2 m), on the limestone walls, were located at least 5 m apart. Systematic sampling was chosen for higher spatial interspersion (Hurlbert, 1984; Cameron and Pokryszko, 2005), of each species in a sampling area, to compensate for the patchy distribution of microsnails and small plot sizes that had been used in this sampling. A plot was located more than 5 m away from the previously sampled plot if it had shown signs of artificial habitat modifications as to minimize confounding effects of human disturbance at karsts near human settlements (Clements *et al.*, 2008). Sampling involved the measurement of environmental variables such as the relative air humidity, ambient air temperature, light intensity, orientation and condition of limestone walls, and plant canopy coverage **(Appendix A)**. This additional information is well known to affect the abundance and diversity of terrestrial gastropods, in general (Jurickova *et al.*, 2008; Raheem *et al.*, 2009) and particularly in rock-dwelling microsnails in this study. Relative air humidity, ambient temperature and light intensity were measured using hygrometer and lux meter. The rest of the environmental parameters (from now onwards will be defined as categorical environmental parameters) were assessed using the definition given in **Table 2.3.**

Table 2.3 Definition used in the assessment of categorical environmental parameters in this study.

Categorical environmental parameters	**Definition**
Orientation of limestone wall	The facing direction of the limestone wall i.e. north, south, east, west
Condition of limestone wall: - Presence or absence of lichen on the wall - Moistness of the wall	 *Covered* indicate observation of more than 50% of the wall covered with lichen *Bare* indicate observation of less than 50% of the wall covered with lichen *Wet* indicate the observation of water on the limestone wall *Dry* indicate the observation of no water present at all on the limestone wall
Plant canopy coverage	*Shaded* indicate the observation of more than 70% of coverage of the plant canopy in the area *Moderately Shaded* indicate the observation of more than 40% but less than 70% of coverage of the plant canopy in the area *Exposed* indicate the observation of less than 40% of coverage of the plant canopy in the area

2.3 Laboratory analysis

2.3.1 Specimens

a. Preservation

Collected specimens were separated according to locations, and in each location they were further divided into two groups: dead and live specimens. Dead specimens were kept in dry bottles and living specimens were preserved directly in 95% ethanol to preserve the tissue.

b. Species identification

Specimens of microsnails were classified and identified by using literatures from Sykes, 1902, 1903; Laidlaw, 1928, 1932, 1949; Tomlin, 1938, 1941; Tweedie, 1947; Benthem-Jutting, 1949, 1952, 1960a, 1960b, 1961a, 1961b; Berry, 1963; and Maassen, 2001. Additional verifications were made with type specimens from the Natural History Museum (London) type catalogue and also from the website of Malay Peninsular Terrestrial Molluscs (http://malaypeninsularsnail.lifedesks.org/) (**Appendix B**). Species identifications were confirmed using characters of shells as shown in **Figure 2.4**.

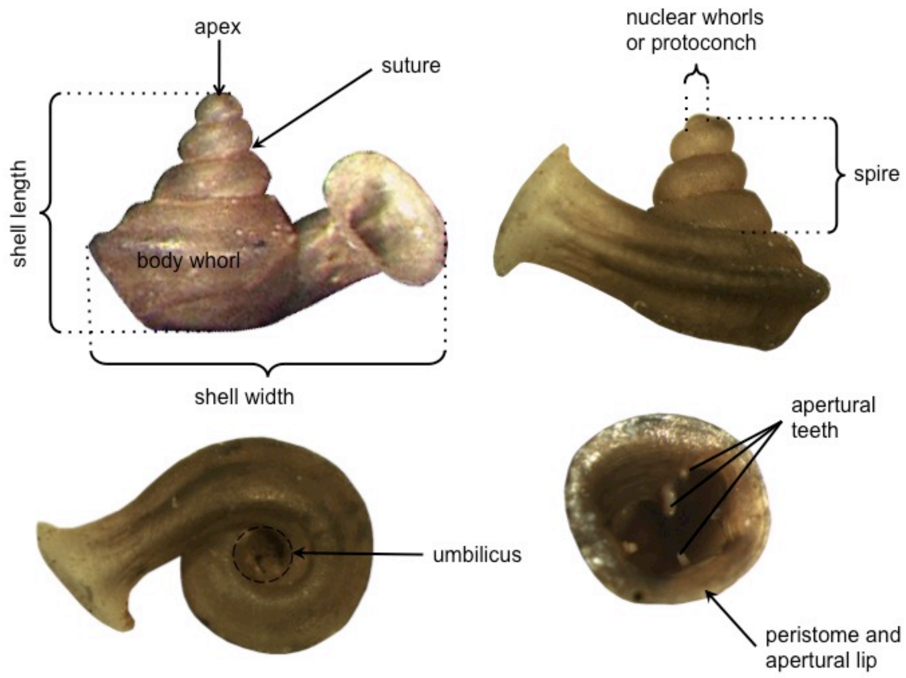

Figure 2.4 Shell morphology (modified from Burch & Pearce, 1990).

c. Shell morphometry

For each population, at least 10 adults, undamaged snails were thoroughly cleaned and dried. Five measurements of the adult shells (H, shell height; SHW, shell width; SPW, spire width; TL, tuba length; θ, degree of tuba elevation; (**Figure 2.5**) were made with an ocular micrometer in a stereomicroscope. Adult snails were defined as having a shell with a reflected apertural lip. All measurements were taken by using the DigiAcquis 2.0 software that was incorporated with the camera that was attached to the compound microscope.

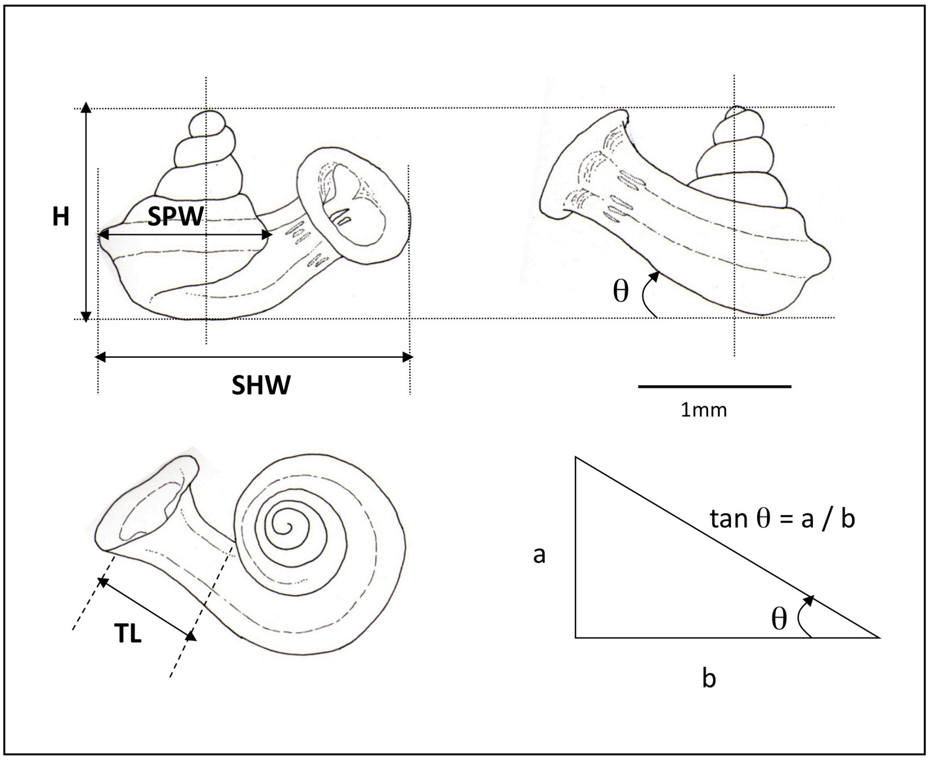

Figure 2.5 Measurements of the shells of vertiginids used in study: H, shell height; SHW, shell width; SPW, spire width; TL, tuba length; θ, degree of tuba elevation.

Relationships among the morphological variables were examined by principal component analysis (PCA) on the correlation matrix. Data were log-transformed to remove possible allometric influences. Hierarchical cluster analysis was performed to identify similar vertiginids based on the shell morphology. Both analyses was done in IBM® SPSS® Statistics, version 19.

2.3.2 Diversity measures

This analysis aims to produce and compare the diversity of vertiginids in every sampling location. Three diversity indices were used according to Ludwig & Reynolds (1988). To calculate these diversity measures, two parameters need to be measured, which were the number of species and the number of individuals counted for each species found in each sampling location.

a. Shannon-Wiener Diversity Index (*H’*)

Shannon-Wiener Index (*H’*) is a measure of the average degree of uncertainty in predicting to what species and individual chosen at random from a collection of S species and N individuals will belong. This average uncertainty increases as the number of species increases and as the distribution of individuals among the species become even. Thus *H’* has two properties as below:

1. *H’* = 0 if and only if there is only one species in the sample
2. *H’* is maximum only when all S species are represented by the same number of individuals, that is, a perfectly even distribution of abundance.

The equation for the Shannon-Wiener function, which uses natural logarithm (*ln*), is

$$H' = \sum_{i=1}^{S} (p^i \ln p^i)$$

Where, S = total number of species

$p^i = n^i / N$

n^i = number of individuals for species $i_1, i_2, i_3, \ldots i_n$

N = total number of individuals

b. Evenness Index (*J’*)

Evenness index (*J’*) will look at the species evenness or equitability. Evenness refers to how the species abundance (e.g. the number of individuals, biomass, cover, etc.) is distributed among the species. When all species in a sample are equally abundant, the evenness index is maximum and decreases toward zero as the relative abundance of the species diverge away from the evenness.

The equation for Evenness index is as below:

$$J' = \frac{H'}{\ln S}$$

Where, H' = value of Shannon-Wiener diversity index

S = total number of species

c. Dominance Index (*D*)

This index aims to study the species dominance level in every sampling location. The equation is as below:

$$D = 1 - J'$$

Where, J' = value of Evenness index

2.3.3 Relationship between environmental parameters and the abundance and species richness of vertiginids

Three environmental parameters, ambient temperature, relative humidity and light intensity were analysed using one-way ANOVA to find the differences between sampling locations. Later, they were subjected to LSD (Least Significant Difference) post-hoc test to find out which location differ from one another. This analysis was done using IBM® SPSS® Statistics, version 19.

Pearson's correlation was used to test the linear relationship between the three environmental parameters (ambient temperature, relative humidity and light intensity) and the abundance and species richness of vertiginids in each sampling location during both sampling seasons. Pearson's correlation test was done using the IBM® SPSS® Statistics, version 19. Other categorical environmental parameters such as orientation, presence of lichen and moisture on the limestone wall, and plant canopy coverage were analyzed with the faunal abundance using non-metric multidimensional scaling (NMDS) analysis in the software PRIMER 5.

CHAPTER THREE:

RESULTS

Three genera and ten species of microsnails from the Family Vertiginidae were recorded from the Langkawi Islands, Kedah. Two genera were from the subfamily Gastrocoptinae and only one genus from the subfamily Nesopupinae. The two genera from the family Gastrocoptinae were *Gyliotrachela* and *Paraboysidia*; and the only genus recorded from the subfamily Nesopupinae was *Nesopupa* (**Table 3.1**). Genus *Gyliotrachela* recorded the most number of microsnails species namely *Gyliotrachela depressispira*, *Gyliotrachela hungerfordiana*, *Gyliotrachela luctans*, *Gyliotrachela salpinx*, *Gyliotrachela transitans helioscopia*, and two unknown species. This is followed by genus *Paraboysidia* that recorded two species of microsnails namely *Paraboysidia frequens* and *Paraboysidia serpa*. The genus *Nesopupa* only recorded one, but unknown species.

Table 3.1 List of microsnails from the family Vertiginidae that were recorded in this study at Langkawi Islands, Kedah.

Subfamily	**Genus**	**Species**
Gastrocoptinae	*Gyliotrachela*	*G. depressispira* Benthem-Jutting, 1949
		G. hungerfordiana (Möellendorff, 1891)
		G. luctans Benthem-Jutting, 1950
		G. salpinx Benthem-Jutting, 1961
		G. transitans helioscopia Benthem-Jutting, 1950
		Gyliotrachela sp. 1
		Gyliotrachela sp. 2
	Paraboysidia	*P. frequens* Benthem-Jutting, 1950
		P. serpa Benthem-Jutting, 1950
Nesopupinae	*Nesopupa*	*Nesopupa* sp.

3.1. Description of Vertiginidae

3.1.1 Genus *Gyliotrachela* Tomlin, 1930

***Gyliotrachela depressispira* Benthem-Jutting, 1949 (Plate 3.2)**

Material examined – Bukit Chintamanis, Pahang (RMNH 5541)

Shell characteristics

a. Size and shapes

The shell of *Gyliotrachela depressispira* is small, measuring 1.5 – 1.8 mm from apex to base (shell height), and 2.4 – 2.8 mm in diameter (shell width). The shell is depressed planiturbinate (low turbin-shaped) with low and almost flat spire.

b. Whorls and sutures

The body whorl produced into an ascending tuba, which rises above the depressed apex of the shell spire. In cross section, the tuba is quadrangular. The shell has 3.75 whorls to where the tuba begins. Nearing maturity, growth of the last half of the body whorl changes direction greatly, continuing upward at about 65° from the direction of the previous shell growth. The first two whorls are raised above the disproportionately enlarged body whorl. The body whorl is sharply shouldered and a furrow running spirally around the upper part of the whorl (dorsal sulcus). Above the furrow, the whorl is more or less rounded. The sutures are well impressed.

c. Type of umbilicus

Umbilicus widely open and bordered on the base of each whorl by a well-defined keel.

d. Apertural teeth

The five major barriers are present – the parietal, angular, columellar and the upper and lower palatal. The parietal and angular are close together, almost joined. The parietal lamella is more deeply set, while the angular lamella continues distally to the flexure of the peristome.

e. Peristome and apertural lip

The peristome is free, continuous, broadly dilated and sinuated at the angulo-parietal lip. The peristome is facing upwards in an almost horizontal plane.

f. Surface markings

The surface is minutely granular. Regular striation occurs according to the growth line.

g. Locality

Gyliotrachela depressispira was found on limestone hill at the southeast of Pulau Tanjung Dendang.